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The effects of health information technology on the costs and quality of medical care☆

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ABSTRACT

Information technology has been linked to productivity growth in a wide variety of sectors, and health information technology (HIT) is a leading example of an innovation with the potential to transform industry-wide productivity. This paper analyzes the impact of health information technology (HIT) on the quality and intensity of medical care. Using Medicare claims data from 1998 to 2005, I estimate the effects of early investment in HIT by exploiting variation in hospitals' adoption statuses over time, analyzing 2.5 million inpatient admissions across 3900 hospitals. HIT is associated with a 1.3% increase in billed charges (p-value: 5.6%), and there is no evidence of cost savings even five years after adoption. Additionally, HIT adoption appears to have little impact on the quality of care, measured by patient mortality, adverse drug events, and readmission rates.

Technology adoption, and information technology in particular, have been linked to productivity growth in a wide variety of sectors. However, a historical perspective suggests caution is warranted in linking any particular technology to the promise of substantial, sustained productivity growth within a specific industry. Work by McKinsey Global Institute (2002) argues that the productivity acceleration of the 1990s, widely attributed to information technology (IT), was concentrated in a limited number of sectors, and IT was only one of several factors that combined to create the productivity jump.

In this paper, I analyze the impact of health information technology (HIT) on the costs and quality of medical care, testing whether the technology has demonstrated potential to improve the productivity of the health care sector. Against a backdrop of persistently high growth in health spending, many policymakers are looking to HIT as a key tool to improve the efficiency of the health care sector, by preventing medical errors, cutting redundant tests, and improving health outcomes. The RAND Institute has projected that HIT will spur a $142–$371 billion per year reduction in health spending (Hillestad et al., 2005).

The Health Information Management Systems Society estimates that hospitals will spend approximately $26 billion dollars on IT applications between 2010 and 2014 (HIMSS Analytics, 2009). These expenditures will be driven partly by a federal program, the 2009 HITECH Act, which will implement reimbursement incentives and penalties designed to encourage HIT adoption. These new incentive payments are projected to increase net Medicare and Medicaid spending by $30 billion over nine years (2011–2019). However, the Congressional Budget Office (2008) estimates the total costs of the legislation to be markedly lower, $19 billion, since it predicts that HIT will reduce medical expenditures and thus reduce related federal spending.

This study focuses primarily on two types of health information technology: electronic medical records (EMR) and clinical decision support (CDS). EMR maintain patient information and physician notes in a computerized database rather than a paper chart. EMR allow the provider to track the patient's health over time and read the input of other consulting physicians. CDS provides timely reminders and information to doctors. CDS may recommend screening tests, flag drug–drug interactions and drug allergy

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information, or discourage the provider from repeating a test by highlighting a previous result. Together, these systems form the backbone of a basic clinical HIT system.

The paper explores several channels through which HIT adoption may affect the quality and quantity of care provided. First, EMR may reduce the effort cost to the physician of prescribing an extensive medical workup, which may increase the intensity of provided treatment. Second, EMR may improve communication across providers, which may in turn increase reliance on specialists and reduce redundant testing. Last, CDS may reduce medical errors and improve routine care by providing timely reminders to physicians. The net impact of these three channels on total medical expenditures, health outcomes, and quality of care is ambiguous.

I perform a detailed empirical analysis of the impact of hospital HIT investment, using Medicare claims data. HIT is associated with 1.3% higher medical expenditures, with the 95% confidence interval ranging from −0.03% to 2.6%. Other results find that length of stay and number of physicians consulted do not change significantly after adoption. Despite the cost increases, HIT is associated with very modest reductions in patient mortality of 0.03 percentage points [95% confidence interval: −0.36 to 0.30 percentage points]. Further, there are no significant improvements in the complication rate, adverse drug events or readmission rate, after HIT adoption.

The results fail to measure a social benefit to HIT adoption over this period, although it should be noted that the finding is local both to the basic types of software systems commonly implemented over the study period, from 1998 to 2005, and the organizational structure of adopting hospitals. I will discuss these limitations further in the penultimate section of the paper.

These findings are estimated in a 20% sample of Medicare claims from 1998 to 2005; the sample includes 2.5 million inpatient admissions at 3880 hospitals. The claims data allows detailed tracking of patients' health outcomes, services rendered, and medical expenditures. HIT adoption is measured at the hospital level from the Health Information and Management Systems Survey (HIMSS).

A fixed effects econometric model exploits within-hospital across-time variation in HIT adoption status to estimate the effects of adoption. The multi-year panel data along with variation in the timing of HIT adoption allows the inclusion of rich controls for time trends beyond those used in conventional difference-in-differences analysis; in particular, I control for state-year fixed effects, adopter-specific time trends, and differential trends that vary according to a hospital's baseline characteristics. I analyze potential threats to validity, testing for simultaneous changes in other hospital investments and probing the robustness of the results to any changes in patient sorting across hospitals.

Buntin et al. (2011) provide a review of recent literature on health IT, finding in a meta-analysis that 92% of studies suggested positive overall benefit to health IT. My analysis has several advantages over previous research. First, it estimates the impact of HIT over a broad, national sample of hospitals, rather than presenting a case study of a single institution or HMO (cf. Bates et al., 1999; Demakis et al., 2000; Javitt et al., 2008). Second, it uses panel data to implement a difference-in-differences strategy, instead of relying on cross-sectional evidence (cf. DesRoches et al., 2010; Himmelstein et al., 2010).

My paper builds upon and complements the recent work on HIT with panel data by Miller and Tucker (2011), McCullough et al. (2011), McCullough et al. (2010) and Furukawa et al. (2010). An advantage of my analysis is that it brings together a large set of outcome variables including medical expenditures and quality of care measures in addition to mortality rates, allowing a rich analysis of adoption costs and benefits; to the best of my knowledge, it is the first large scale analysis of the impact of HIT on billing expenditures. Lastly, I implement a robust empirical strategy that controls for a rich set of state-by-year fixed effects and differential time trends that vary by hospital characteristics, rather than imposing uniform time trends across hospitals. This more flexible approach is particularly important for identifying the impact of HIT adoption on medical expenditures, as described in more detail in Section 3.1.

The paper proceeds as follows. Section 2 describes the data in more detail and discusses the HIT adoption decision. Section 3 presents the empirical strategy and results. Section 4 analyzes the policy implications and interpretation of these findings. The final section summarizes the results and concludes.

1. Data and descriptive statistics

1.1. Data sources and sample construction

I study the impact of HIT on the costs and quality of care between 1998 and 2005, using data from three sources: Medicare Claims Data from the Center for Medicare and Medicaid Studies, the Health Information and Management Systems Survey (HIMSS) conducted by the Dorenfest Institute, and the American Hospital Association Annual Survey.

The HIMSS tracks HIT adoption at hospitals across the country; it includes questions about a wide variety of HIT functionalities and the timing of technology adoption. The annual survey includes 90% of non-profit, 90% of for-profit, and 50% of government-owned (non-federal) hospitals. I construct an indicator variable of HIT adoption which equals one if the hospital has contracted either CDS or EMR.[1] As reported in Table 1, panel A, 54% of hospitals have contracted at least one of these two technologies by 1998, and an additional 23% of hospitals contract HIT for the first time during the study period.

The HIMSS data is, to the best of my knowledge, the only broad panel data on HIT adoption over this period. A shortcoming of the data is that although it differentiates the adoption of many different software types, it does not record information on the quality of the HIT systems or the precise functionalities they include. I turn to the 2008 survey conducted by the American Hospital Association, reported by Jha et al. (2009a,b), to understand which specific capabilities are likely to be included in the HIT installations I observe. This smaller survey covers 2370 hospitals, as compared to the 3880 hospitals included in the broader HIMSS data, and provides a snapshot of HIT installations in the 2008 survey year, a few years after the end of my study period in 2005.

Jha et al. (2009a) report that the four most common components of EMR are demographic characteristics (fully implemented in one or more unit at 89% of surveyed hospitals), medication lists (68%), discharge summaries (66), and list of current medical conditions (48.5); these four functionalities are likely to be features of the EMR systems I observe.

The most common features of CDS are drug allergy alerts (fully implemented in at least one unit at 68% of surveyed hospitals) and drug–drug interaction alerts. Roughly half of the CDS systems includes clinical guidelines and reminders, such as reminders to prescribe beta blockers after a myocardial infarction (30%) or provide pneumonia vaccines (38).

I link the HIT adoption survey to data on all Part A and Part B Medicare claims for a 20% sample of patients from 1998 to 2005. The Medicare claims data allows me to construct measures

[1] In theory, CDS and EMR may have differential effects on the studied outcome variable; however, in practice, I do not find any evidence of significant differences between the effects of these two technologies. As a result, I combine them into a single indicator for HIT adoption.